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WHEAT STORAGE IN THE EVER-NORMAL GRANARY

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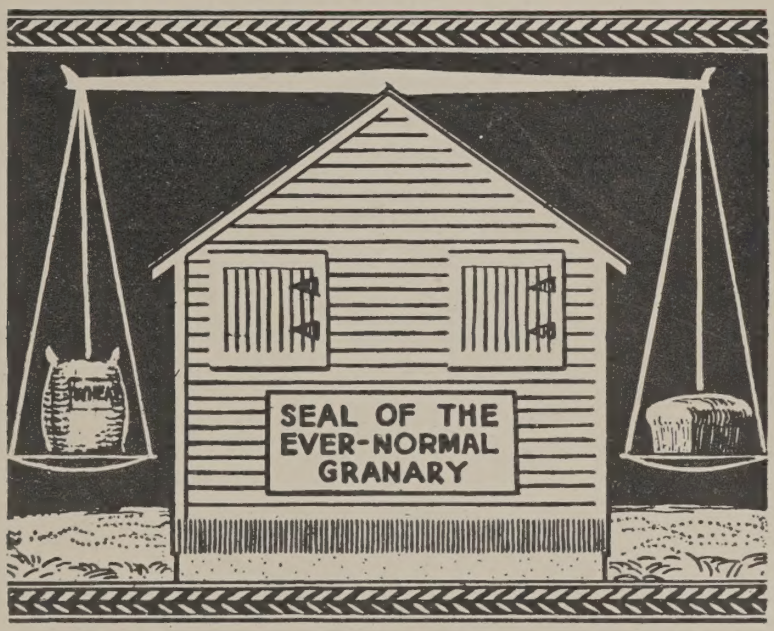

TO BALANCE MARKET SUPPLY WITH CONSUMPTION BY CARRYING OVER SURPLUS WHEAT FOR USE IN SHORT CROP YEARS

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Adjustment Administration

38-WHEAT-1 -- COMMODITY INFORMATION SERIES -- ISSUED MAY 1938

CONTENTS

THE EVER-NORMAL GRANARY IDEA

The Ever-Normal Granary idea is as old as the ancient civilizations and as new as our modern problems of economic instability. City people are in search of greater economic security, more continuous production, and employment. Farmers likewise seek greater stability in their production, prices, and income. They can no longer bank on world markets taking their bumper crops, and consumers cannot bank on reduced tariffs and greatly increased imports in years of great crop shortages.

Amidst the great dislocations of the past decade in world economic and political affairs, there have appeared most extreme fluctuations in weather and crop yields. For example, the worst droughts in a hundred years struck our grain crops in 1934 and 1936, and in 1937 we had record crop production. Weather conditions in most parts of the country have shown greater fluctuations and uncertainties than in former generations.

One of the byproducts of a troubled age, when the ways of the past no longer serve the common welfare effectively, is an increased effort to discover new devices. Most of the agricultural programs introduced by the Department of Agriculture in recent years might be classed under the Ever-Normal Granary idea. In the soil-conservation programs we are searching for the best ways of retaining and increasing soil fertility. In the adjustment programs of the grain and livestock areas we are attempting what thoughtful farmers have been urging for years, a system of storing surpluses for years of deficit, so as to maintain a more continuous flow of livestock products to market at more stable prices for both grains and livestock. In the crop-insurance program for wheat we are enabling wheat growers to cooperate in an effort to reduce the effects of the hazards of production. This insurance plan, if successful, doubtless will be extended to corn, cotton, and perhaps other crops.

These elements of the Ever-Normal Granary idea, as we grow in experience with them, should give us a more orderly farm production to meet all the normal requirements of a growing country both for domestic and export markets. They should give us better control of our natural resources, with great improvement in the storage facilities on farms, more efficient farm management, greater stability in the consumer food budget, and a substantial contribution to the economic stability of all those engaged in the marketing and processing of farm products.

The important steps of providing practical and safe (not elaborate or costly) storage buildings and of caring for farm-stored wheat so that it will not deteriorate can be taken only by farmers themselves. Farmer cooperation in carrying out the requirements outlined in this publication is needed in giving effect to the whole idea.

H A Wallace

WHEAT STORAGE IN THE EVER-NORMAL GRANARY

This bulletin was prepared by representatives of the Bureaus of Agricultural Economics, Agricultural Engineering, Biological Survey, Entomology and Plant Quarantine, and Plant Industry, and the Agricultural Adjustment Administration in the Department of Agriculture, with the assistance of engineers and agronomists of the State agricultural colleges of Illinois, Indiana Iowa, Kansas, Maryland, Ohio, and Oregon

The Agricultural Adjustment Act of 1938 provides an Ever-Normal Granary plan for wheat. This program includes acreage allotments, crop insurance, commodity loans, and, in times of burdensome surpluses, marketing quotas.

THE EVER-NORMAL GRANARY FOR WHEAT

The crop-insurance provisions of the act are designed to alleviate economic distress among producers and consumers, caused by crop failures due to drought or other causes. Wheat paid in as premiums under this plan will be stored as reserves and paid back to producers in years of crop shortage or failure. One effect of this will be to keep excessive wheat surpluses off the market in years of high production and to carry them over to be paid to farmers and marketed by them in years of crop shortage. This will help to maintain a reserve of wheat and to stabilize producers' incomes. It will also protect the consumer by helping to stabilize food supplies and prices.

Upon recommendation of the Secretary of Agriculture and with the approval of the President, the Commodity Credit Corporation is authorized to make loans on wheat available to farmers who are cooperating in the agricultural conservation program during any marketing year (July 1 to June 30) beginning in a calendar year in which the farm price of wheat on June 15 is below 52 percent of the parity price on that date, or the July crop estimate for wheat is greater than a normal year's domestic consumption and exports. These loans are to be made at rates not less than 52 percent and not more than 75 percent of the parity price of wheat at the beginning of the marketing year.

Furthermore, when marketing quotas are in effect loans will be made to farmers who are not cooperating in the agricultural conservation program, on that part of their crop which would be subject to penalty if marketed, at 60 percent of the rate of the loans available to cooperators.

The marketing-quota provisions of the act apply to all producers and afford them a cooperative means of minimizing excessive surpluses and shortages of wheat. Quotas are to be applied only when crops and carry-overs are exceptionally large, and then only if approved in a producers' referendum.

Whenever it appears that the total supply of wheat at the beginning of any marketing year will exceed a normal year's domestic consumption, plus exports, by more than 35 percent, the Secretary of Agriculture shall proclaim that fact not later than May 15. Thereupon, beginning July 1, a national marketing quota for wheat shall be in effect, if approved in a referendum of the farmers affected. If two-thirds of the farmers voting in the referendum approve the national marketing quota, individual farm marketing quotas will be established. Sales in excess of such quotas will be subject to a penalty of 15 cents a bushel.

No marketing quota with respect to the marketing of wheat shall be in effect for the marketing year beginning July 1, 1938, because the act specified that no such quota was to be established unless, prior to the date of the proclamation by the Secretary, provision has been made by law for the payment, in whole or in part, in 1938 of parity payments with respect to wheat. No such provision was made.

FARMER HAS OPTIONS

Under the Ever-Normal Granary program a producer has three choices of what to do with wheat which he does not want to sell or which is in excess of his farm marketing quota.

1. He may use as much of the wheat as is required, to pay his premium on crop insurance. Crop-insurance reserves will be in the form of stored wheat, and indemnities due to insured farmers will be paid in the form of wheat or, when paid in cash, its market value on the date when the claim is settled.

2. In years when loans are offered he may obtain a loan on wheat of acceptable grade, stored in an elevator or warehouse that meets the Federal requirements. The amount of the loan will vary according to the grade of the wheat. When wheat is so stored, the warehouse receipt will be evidence of the stored wheat and will serve as collateral for a Federal loan.

3. In such years he may store his wheat on his farm and obtain a loan provided his wheat and granary meet all the requirements and are not located in a region where insect and weather hazards are too great for safe storage.

GOOD WHEAT, PROPERLY STORED, IS REQUIRED SECURITY

The act provides that the stored wheat shall be the only security the Government has for its loan. Hence it is essential to the success of the Ever-Normal Granary that only good-quality wheat be stored and that it be placed in bins or granaries where it will not be subject to losses in quantity or to damage from moisture, insects, rodents, or other sources.

The bin or granary used for farm storage of wheat should be a substantial and permanent structure which will:

1. Hold the wheat without loss of quantity.

2. Protect the wheat against weather conditions which may cause deterioration in quality.

3. Afford reasonable protection against thieves, rodents, birds, poultry, and insects.

4. Permit effective fumigation for the destruction of insects.
5. Provide reasonable safety from fire and wind.
6. Require forcible breaking in order to be entered when sealed.

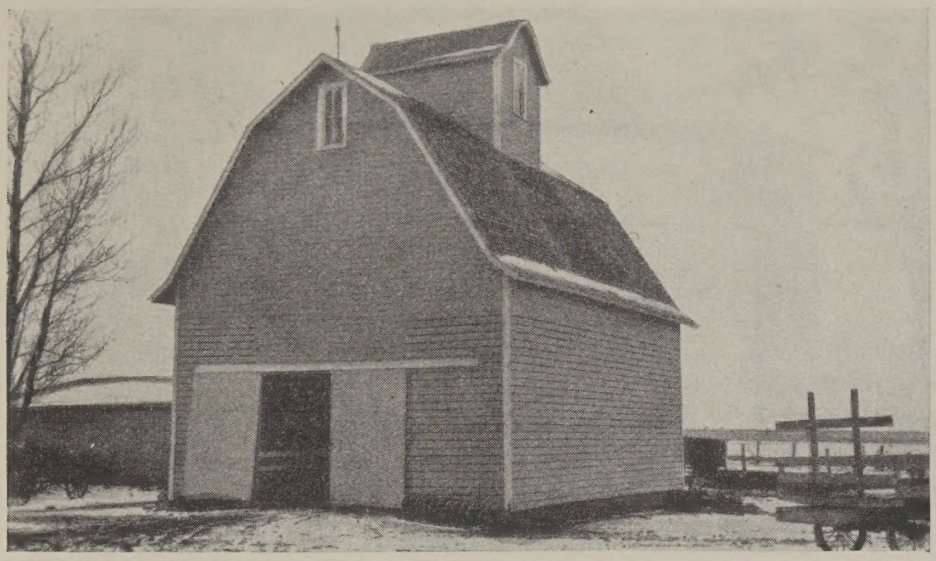

FIGURE 1.—This type of combined crib and granary provides good storage for wheat or other grain in the bins over the driveway.

This bulletin deals primarily with the problems of storing wheat on farms. It gives information about the quality of wheat that can safely be stored, methods of conditioning wheat for safe storage, kinds of granaries, and methods of protecting stored wheat from

FIGURE 2.—This granary, if well built, will meet loan requirements. Size 14 by 24 feet; four bins, each holding 450 bushels. The work alley provides space for cleaning and conditioning grain. Design No. 5528.[1]

rodents and insects. This information is of particular interest to farmers who plan to store on their own farms the wheat which is to be security for Government loans.

[1] See p. 12, How to Order Plans.

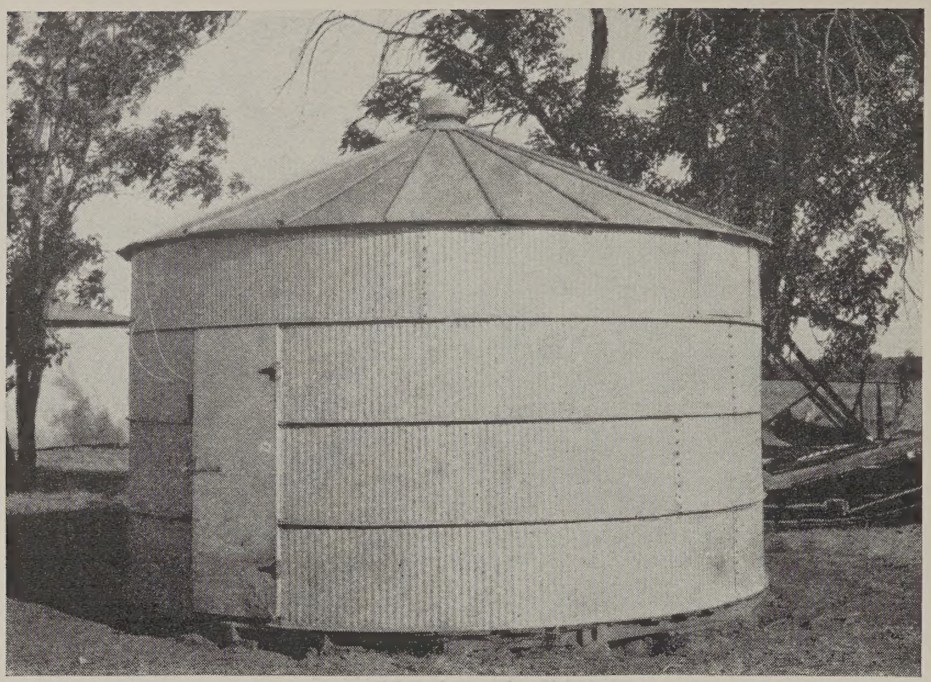

FIGURE 3.—An acceptable bin if inspection shows that roof and wall joints are tight and there are no leaks around doors. The location in a clean, shaded place away from other buildings is good.

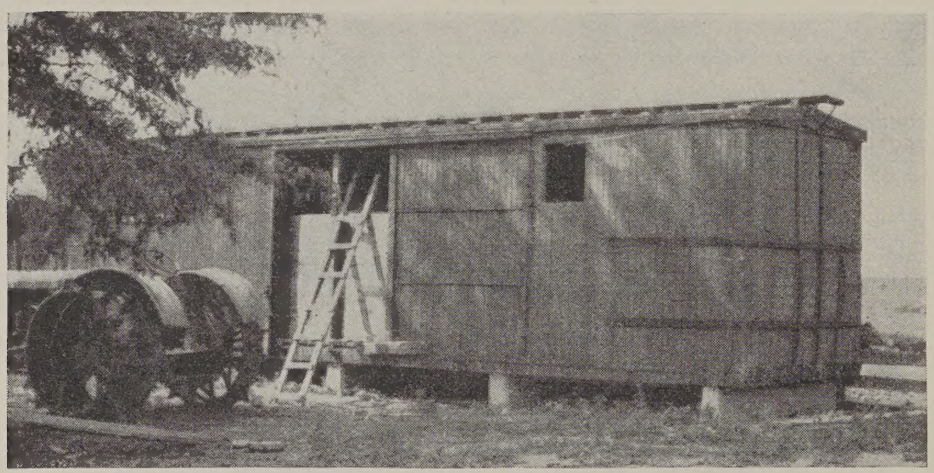

FIGURE 4.—A substantial farm storage, total capacity about 2,000 bushels. Note concrete foundations and good clearance above ground. A door for the filling opening is needed. If the space between the doors were left empty it would be easier to move the grain in case of heating or other trouble.

QUALITY OF WHEAT

The best guarantee against spoilage of stored wheat is for it to be dry when it is stored. Heating, mold growth, and insect damage are all speeded up by dampness, and it is difficult to improve the condition of the wheat after it is in the bin. Farm-stored wheat at the time when it is sampled for Federal loans should not contain more than 13 percent moisture, except that hard red spring and durum wheat may contain up to 13.5 percent moisture.

These limits are 1 percent lower than the moisture contents acceptable for wheat stored in federally licensed elevators or warehouses. This stricter requirement for farm-stored wheat is necessary because wheat in federally licensed storage is under constant observation, equipment for cooling and conditioning is available there, and the storage company is bonded to deliver the same grade of wheat that it received.

Producers should not store damp wheat on the farm with the expectation of getting Federal loans unless they have the necessary facilities and equipment to condition the wheat before the loan is made and to maintain it in safe condition. Wheat offered as collateral for Federal loans must meet the moisture and grade requirements necessary for safe storage, and the owner must safeguard it against any loss in quantity or deterioration in quality.

FIGURE 5.—Granary not acceptable until protected from surface water that collects on up-hill side (indicated by arrow). A ditch is needed to intercept and carry away the run-off.

GRAIN MUST BE ACCESSIBLE FOR SAMPLING

When a loan is to be requested, the wheat will have to be sampled properly. The wheat must be accessible for probing throughout the entire lot of grain, so that a correct and representative sample can be obtained for grading. If the wheat is not more than 6 feet deep and there is 2½ feet head-room, there will be no sampling difficulty.

If the bin has a greater depth of wheat or insufficient head-room, it may be necessary to move sufficient wheat to permit the sampler to probe all portions of the lot.

In cases where there may be difficulty in obtaining representative samples of the grain, the local agricultural conservation committee should be consulted before the bin is filled.

REQUIREMENTS FOR BINS AND GRANARIES

Types of bins and granaries which are satisfactory for farm storage of wheat, and faults that should be remedied before wheat is stored, are described in the following sections. Buildings which do not meet requirements can often be repaired or remodeled at reasonable cost.

LOCATION AND SURROUNDINGS [2]

The granary should be in or near the farmstead group for protection against loss by theft. It should be located on a well-drained site with firm soil and safe from damage by surface water (fig. 5). In no case should bins be located on river or creek bottom land subject to overflow.

The granary should be far enough from other buildings and from stacks of straw, hay, etc. to reduce fire danger. The site should be kept free from weeds, trash, and junk that constitute fire hazards and harbor rats and mice (figs. 7 and 8). A shady location is desirable, especially for small bins.

STRUCTURAL REQUIREMENTS

Foundations.—The foundation should have footings large enough to prevent the bin from settling. One square foot of surface bearing on the ground for each 60 bushels of wheat is satisfactory on most

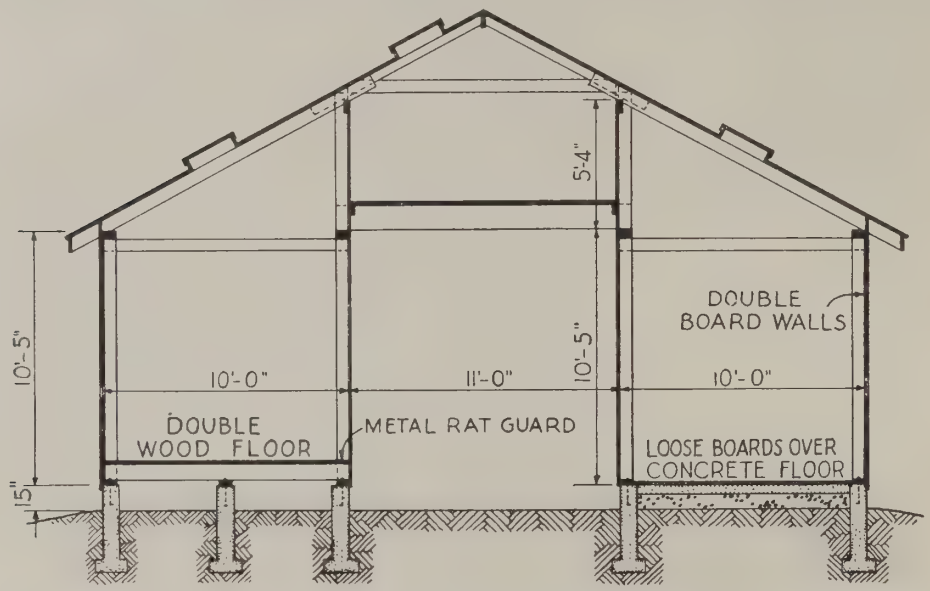

FIGURE 6.—Cross section of granary design, showing both wood and concrete floors. For joist and stud sizes see tables 1 and 2. Note anchor bolts, studs lapping and spiked to wood joists, metal rat guards over sills of wood floor, and double-boarded walls with no inside lining. (For plan and perspective see fig. 13.)

soils. The foundation should extend deep enough into the ground to insure stability, guard against structural failure, and prevent undermining by water or animals (fig. 6). Foundation bolts help to prevent damage to the bin by windstorms. Foundations should be high enough (figs. 4 and 6) to give good air circulation under board floors and to discourage rats from building their burrows up against them. Two feet above the ground is a good height for the floor.

Buildings like the one shown in figure 25 should be raised 2 feet from the ground and supported on blocks or posts protected near the tops by metal pans or bands.

Loose stone foundations (figs. 7 and 8) are unsteady and often make ideal harbors for rats. A continuous foundation wall supporting a wooden floor should have screened openings for ventilation.

[2] Suggestions on building arrangement may be found in Farmers' Bulletin 1132, Planning the Farmstead.

FIGURE 7.—A bad risk unless improvements are made. Foundation is unsteady, sills may be decayed, and studs are not strong enough to carry load if bin is filled to capacity. Walls and doors not watertight, and numerous unsealed cracks make effective fumigation impracticable. Weeds, when dry, will increase fire risk. In case extensive repairs are contemplated, the local agricultural conservation committee should be consulted as to requirements.

FIGURE 8.—Bin not acceptable. Loose stone foundation and junk piled at end of building make ideal rat harbor. Sills, siding, and roof in such poor repair that serious loss of grain might occur at any time. Material might be salvaged and used in constructing new bin.

Floors.—Wood floors must not be loaded beyond the capacity of the joists. Table 1 shows the depth to which wheat may ordinarily be safely stored on joists of common sizes with ordinary spans and spacings. Flooring and joists must be inspected carefully for termite damage [3] and decay. A joist which is split near the center of its height for a length from the end equal to or more than its height, is weakened by about one-half. Similar reduction in strength may be caused by large knots, especially if they are near the lower edge of the joist in the center half of its length.

TABLE 1.[1]—*Safe depth of wheat in bins with joists of common sizes and spans for 24-, 16-, and 12-inch spacings*

Size of joist (inches)	Depth of wheat for—				
	6-foot span	7-foot span	8-foot span	9-foot span	10-foot span
	Feet	*Feet*	*Feet*	*Feet*	*Feet*
24-INCH SPACING					
2 by 6	3				
2 by 8	4½	4	3		
2 by 10	6	5	4	3½	3
2 by 12	8	6½	5	4½	4
16-INCH SPACING					
2 by 6	4½				
2 by 8	6½	6	4½	3½	3
2 by 10	9½	8	7	5½	4½
2 by 12	12	10	8	7	6
12-INCH SPACING					
2 by 6	6	4			
2 by 8	9	8	6	5	
2 by 10	12	10	8½	7½	6
2 by 12	16	13	11	9½	8

[1] This table is based on the ordinary commercial sizes of lumber. If the joists are full size rather than nominal the depth of grain can be increased one-third. If soft, lightweight lumber such as cottonwood is used, the depth of grain should be reduced one-third.

A tight floor is required to hold grain and prevent escape of fumigating gases. Any small holes may be covered with sheet metal nailed into place. Leaky floors should be covered with new flooring, with paper between the new and old layers. Sections of the floor that have been cut by rats should be covered with tin or with hardware cloth before the new flooring is laid.[4] Where cracks are small, covering the floor with reinforced paper may be satisfactory. Material with a tar odor should not be used because wheat absorbs odors.

Concrete floors in bins that are to be used for long-time wheat storage should be not less than 8 inches above the outside surface of the ground, and should be underlaid with hollow tile or with at least 6 inches of coarse gravel.

Concrete floors should be covered with loose boards to reduce spoilage of wheat near the floor. Where the ground around the bin is often moist a moisture barrier under the boards is a desirable additional safeguard. It may be provided by: (1) Painting the concrete when dry with two coats of asphalt-aluminum, or (2) placing under the boards a layer of vapor-proof paper, such as duplex reinforced kraft paper or roll roofing.

[3] See Leaflet 101—Injury to Buildings by Termites.
[4] Farmers' Bulletin 1638, Rat-Proofing Buildings and Premises, gives information on this subject.

In the case of new concrete floors the moisture barrier may be provided by allowing the 3-inch base to set and dry, then mopping it with enough hot asphalt so that the final surface has a high gloss and is smooth, and finally applying a 1-inch cement-mortar finish.

Except in the dryest localities, concrete floors that are less than 8 inches above the ground (fig. 9) should be raised by means of board overlays on wood joists, with the space between the concrete and the boards ventilated and screened to keep out rats and mice, or high enough to admit cats.

Except in sections where wheat is very dry when stored, bins with metal floors should be set on a tight deck of boards or planks which

FIGURE 9.—An unacceptable storage because of location in feed lot, floor being too close to ground, and walls leaky.

will provide some protection against sudden changes in temperature. Floors of metal bins should be at least 8 inches above the surface of the ground. In regions of deep snows they should be higher to prevent water from melting snow from running in. It is good practice to slope the bin slightly toward the door.

Walls.—Walls of wheat bins must be strong enough to withstand the bursting pressure of the grain. The size and spacing of studs affect the strength of the walls. Table 2 shows the safe depths of wheat for common sizes and spacings of studs. The studs should be securely fastened to the floor system or otherwise tied across.

TABLE 2.[1]—*Safe depth of wheat in bins with studs of common sizes and spacings*

Stud size (inches)	Spacing center to center	Depth of bin	Depth of wheat	Size of studs	Spacing center to center	Depth of bin	Depth of wheat
	Inches	*Feet*	*Feet*	*Inches*	*Inches*	*Feet*	*Feet*
2 by 4	24	8	4	2 by 6	24	8	7
2 by 4	16	8	6	2 by 6	16	10	8
2 by 4	12	8	7	2 by 6	12	10	9

[1] This table is based on the ordinary commercial sizes of lumber. If the studs are full size rather than nominal, the depth of grain can be increased one-third. If large knots occur in any of the studs or if the lumber is soft and lightweight, ties should be used across the bin. Studs should be well fastened to the floor system.

Bin walls must be tight. Preferred construction for frame bins calls for two thicknesses of material on the outside of the studs, with a layer of good paper between, and no lining inside the studs. Sheathing may be of shiplap, matched boards, or plywood Three-eighths-inch plywood may be used with 16-inch stud spacing for depths of grain up to 5 feet and with 12-inch stud spacing for depths up to 9 feet. For wider stud spacings or greater depths of grain, a greater thickness is needed. Sheathing must be well nailed; use two 10-penny nails per board for the bottom half of bins not more than 10 feet deep, or 6-penny nails spaced 3 inches with plywood. For the upper half of the bin use two 8-penny nails per board, or space 6-penny nails 4 to 6 inches for plywood.

FIGURE 10.—Failure of a granary due to inadequate nailing and tying of the studs.

Lay waterproof paper over the sheathing and cover with lap or drop siding, shingles, or sheet metal. Nail siding to the studs, not to the sheathing.

In bins with walls which are too weak (fig. 10) to permit being filled to full height, cross ties of wires or rods may be installed for safety.

All loose boards in old bins should be renailed and all defects in the wall repaired before the bins are filled. Single walls of plain boards may be made tight by applying building paper and an additional layer of siding or by a lining of matched boards or plywood. The lining should start 4 inches above the floor to leave space for cleaning out grain that may get between the wall and lining. All holes where ro-

FIGURE 11.—A metal bin that needs repair. Leaky wall at right of door must be fixed and battered roof and filling door inspected to make sure that rain cannot beat in, nor the roof blow off. Additional guy wires are needed when bin is empty.

dents might enter the wall should be blocked. If a structurally sound wall cannot be made practically gastight without undue expense it should be lined with a strong grade of paper securely tacked into place. This is to make fumigation practicable. Masonry walls should be thoroughly pointed up on the outside and waterproofed to prevent rain driving through. Unless the wall is known to be dry, it should be furred with 2 by 2's and lined with matched lumber or plywood with an opening at the bottom of the lining for cleaning. Metal bins should be examined (fig. 11), missing bolts replaced, and all joints drawn tight.

Partitions should be graintight and as nearly gastight as possible. To prevent unauthorized entry to the bin it is desirable to extend pro-

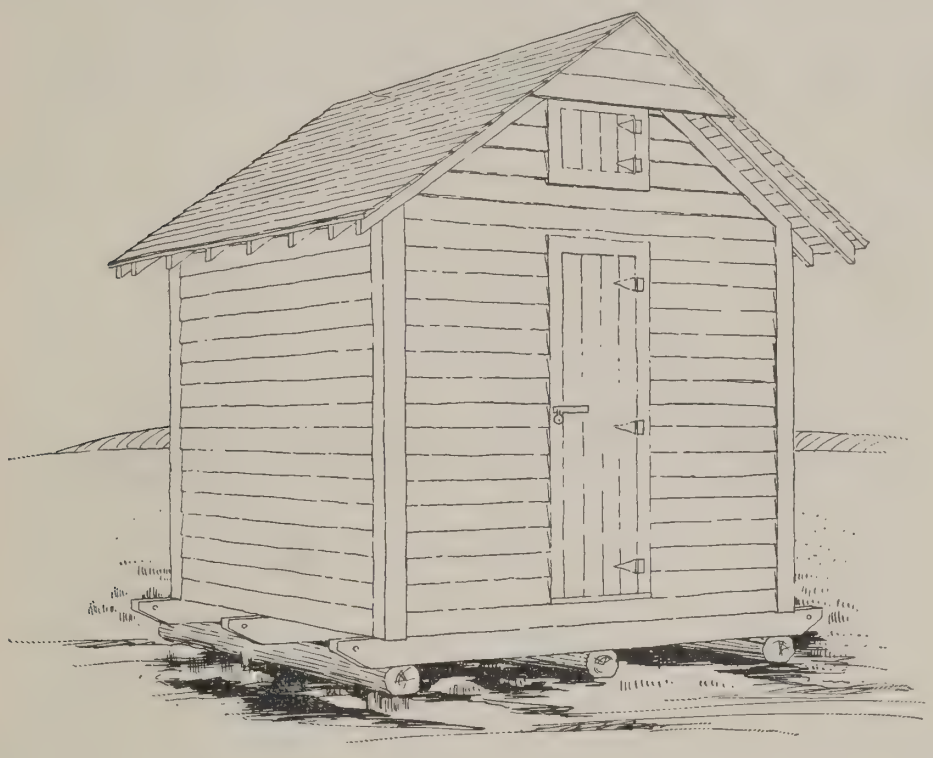

FIGURE 12.—A movable bin, capacity 500 bushels. Design No. 5530. Same style but 1,000-bushel capacity, Design No. 5531.

tective partitions to the roof or ceiling. Where this is not done the space above the bin must be enclosed with woven wire.

Roofs.—The roof must be watertight, and substantial enough to last for the duration of the loan. Any standard roofing material is acceptable if in good condition, but roofs covered with tarred felt or similar lightweight materials are not suitable.

Doors and windows.—All doors and windows must be weatherproof, and safe against leakage of grain. Grain doors must be tight enough to hold gases when fumigating is going on. For this reason they should be covered on the inside, before grain is placed in the bin, with tough paper overlapping the entire opening and the jambs. The main entrance door should be fitted with safety hasp for padlock or

other seal. All other openings should be fastened on the inside or nailed shut so that no unauthorized person may enter the bin or remove the grain.

Ceilings.—If there is storage space above the bin a tight ceiling should be provided to protect the grain from foreign material.

HOW TO ORDER PLANS

Working drawings and bills of materials for granary designs which are shown in this bulletin may be requested from the extension service of your State agricultural college or from your county agent. Refer to the number of the design as given in this bulletin.

Design No. 5534 (capacity: 3,200 bushels of ear corn and 2,000 bushels of small grain) and Design No. 5535 (capacity: 900 bushels of ear corn and 2,000 bushels of small grain) are not illustrated in this bulletin, but are also available. Additional designs adapted to particular States may be obtained from your State extension service.

TYPES OF GRANARIES

Since wheat in the Ever-Normal Granary will be set apart from the ordinary farm supply, separate storage space will be needed. If

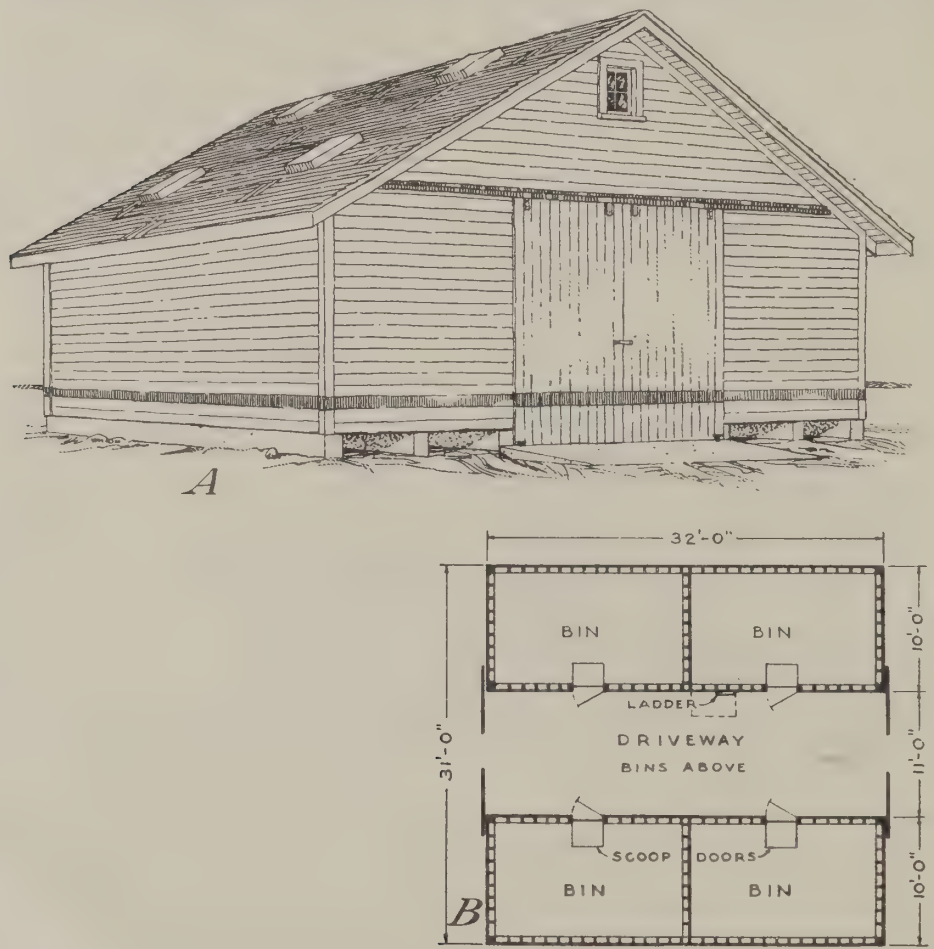

FIGURE 13.—A 6,400-bushel granary for use with portable elevator. Capacity of four lower bins 1,250 bushels each; of two upper bins, 700 bushels each. *A*, perspective; *B*, plan. (For cross-section see fig. 6.) Design No. 5529.

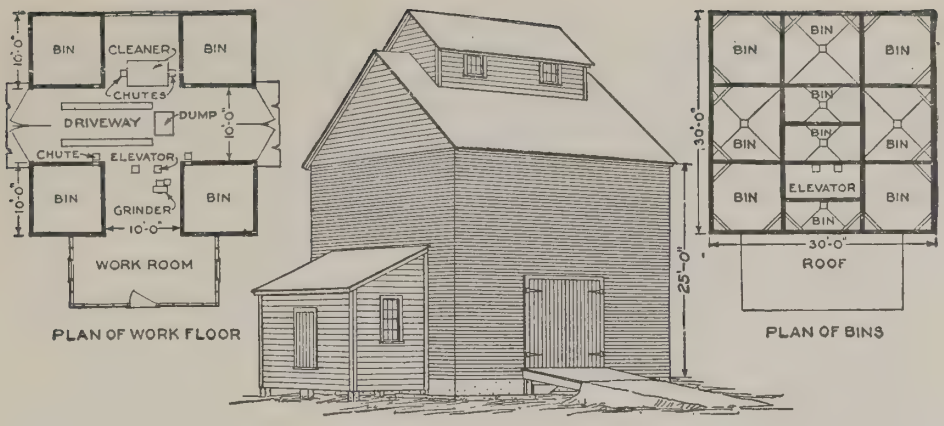

FIGURE 14.—Farm grain elevator of crib construction, suitable for storing from 6,000 to 10,000 bushels of wheat. The storage contains 10 bins with inside dump and elevator and space for cleaning and grinding machinery. One or more bins could be sealed separately. Design No. 5532.

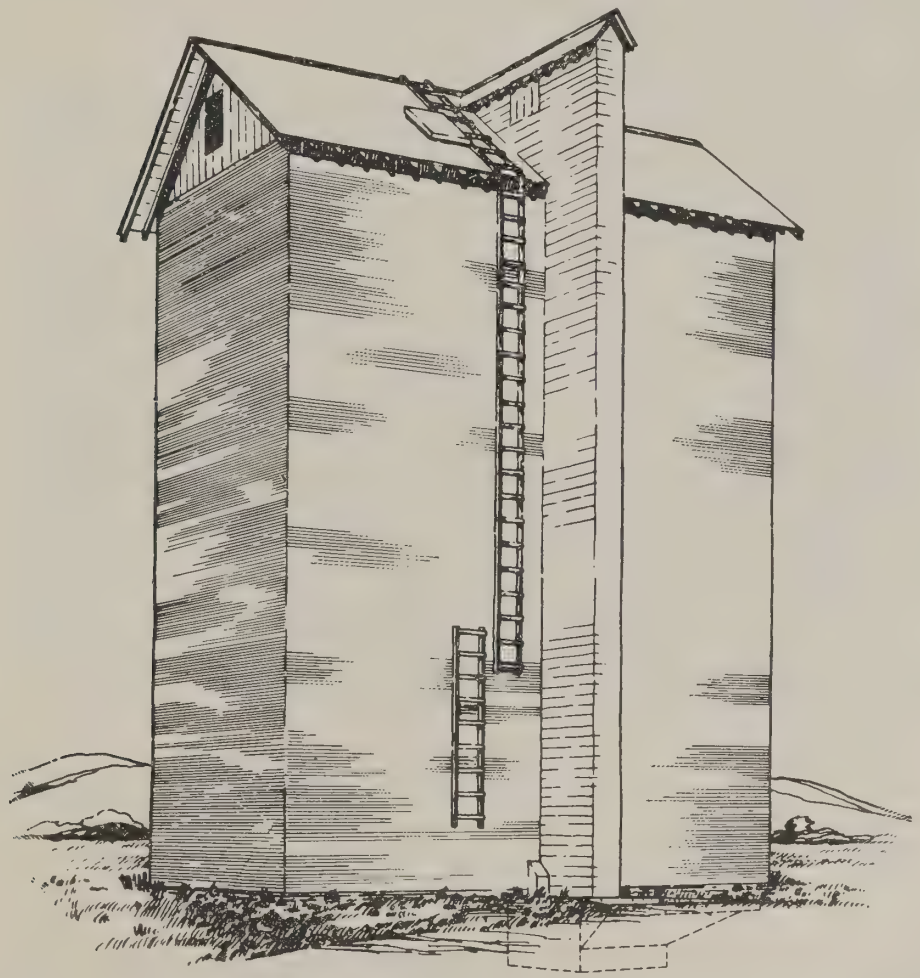

FIGURE 15.—Two-bin crib-construction grain storage with outside dump and enclosed elevator, no inside working space. Total capacity 11,500 bushels. Design No. 5093

FIGURE 16.—Bin not acceptable for loan because of unprotected condition and likelihood of damage by insects, barn odors, moisture, rats, and mice. It would be impracticable to fumigate a barn like this.

FIGURE 17.—Unacceptable barn storage. The roof leaks and rain or snow might beat into the bin through the large doorway. Unbattened barn boards do not exclude rain and are rotting and pulling away from the sill, allowing wheat to leak out. Low window would be easily broken. Absence of rat-proofing adds to risk. Lack of floor above bin would make sealing difficult. Connection of barn with other buildings increases fire risk. Fumigation of this bin would not be practicable on account of fire hazard.

there is already plenty of grain-storage space on the farm, certain bins should be selected and made ready for inspection and filling before harvest begins. In selecting bin space or when considering new construction for Ever-Normal Granary use, the following facts about the most common types of storage should be kept in mind.

A single bin (fig. 12) that can be placed in a safe location out of the way of ordinary operations will provide satisfactory storage for wheat that is dry and in good condition when stored, but does not provide space where the wheat can be conditioned if trouble develops. On the other hand, the single bin may be more easily fumigated and is less likely to be reinfested with insects than is a bin in a larger building.

Granaries with several bins and a working floor (fig. 2) or a driveway (fig. 13) have several advantages over isolated bins, since grain in such granaries can be cleaned, moved, or spread out in a thin layer if necessary to prevent heating with a minimum of labor, and in any kind of weather. A granary divided into several bins permits more flexibility in sealing and releasing grain than if only one large bin is available. A power-operated elevator is a great convenience in filling bins and in moving grain to condition it. For types of elevator-equipped buildings see figures 1, 14, and 15.

The overhead bins in large corn cribs (fig. 1) provide good storage space for grain, except in the southern edge of the Corn Belt, where insects harboring in the corn may attack the stored grain.

For several reasons long-time storage of wheat in barns is not recommended. It involves greater risk of damage by insects harbored in infested feeds, screenings, or waste grain. Fumigation is almost certain to be required to protect the grain, and there is a serious fire hazard in the use of carbon disulphide in a barn. Fire insurance may be voided while carbon disulphides being used. Noninflammable fumigants are expensive and the more frequent fumigation required under barn conditions makes their use impracticable.

FIGURE 18.—Type of barn storage most nearly meeting requirements. Barn is well constructed and in well-drained location. Bin completely enclosed with strong tight walls, floor, and ceiling; surroundings clean.

Fire hazards from other causes are also greater in a barn than in a building used only for grain storage, and it is more difficult to protect the grain from damage by rodents. There is also the possibility that moisture or barn odors may be absorbed by the wheat. Figures 16 to 19 illustrate types of barn storage, both desirable and undesirable.

FIGURE 19.—Bin illustrating points to be watched in barn storage. While general condition of barn is excellent, dampness of bin floor has caused loss of grain. It should be protected as described on page 8. The ceiling is of loose boards that allow rats to enter and dirt to fall through cracks. Unless masonry walls have been built with special care and are known to be dry, they should be furred and lined to keep grain from touching them. *A*, exterior; *B*, interior.

LOANS FOR IMPROVING STORAGE FACILITIES

Farmers who are unable to provide satisfactory bins or granaries without some financial assistance may be eligible for loans from the Farm Credit Administration, the Farm Security Administration, or lending agencies insured by the Federal Housing Administration. Information regarding such loans may be obtained from county agricultural conservation committees or from county agents.

METHODS OF CONDITIONING WHEAT

The best method of conditioning wheat is to thresh only when the grain is dry. Removing excess moisture after the grain has been threshed and stored is difficult and expensive under normal farm storage conditions. If, however, damp wheat is threshed because of adverse weather, the following methods of conditioning may be useful:

1. *Cleaning.*—The removal of weed seeds, chaff, and other foreign material by cleaning will always aid in keeping the wheat. Clean wheat has better natural circulation of air, and heat can pass off from it more easily. Running wheat through a fanning mill tends to have a cooling and slight drying effect.

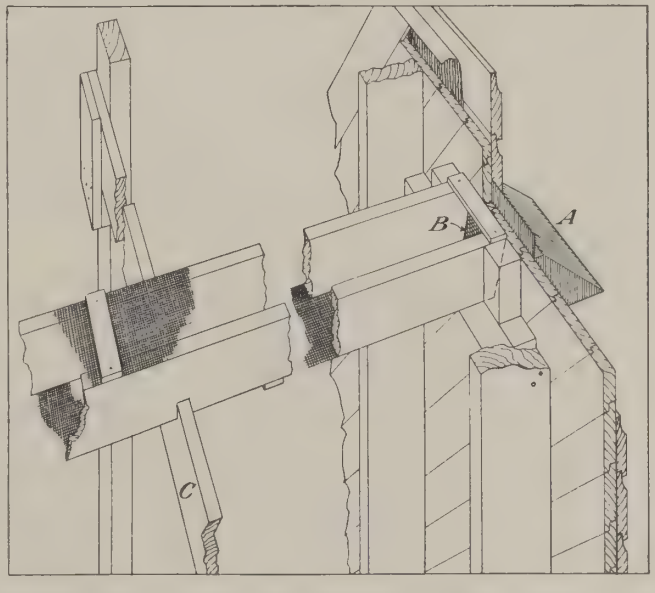

FIGURE 20.—Removable horizontal flues with 1- by 4-inch board sides spaced 4 inches. Top covered with fly screen. *A*, hood to keep out rain. *B*, fly screen covering opening in wall. *C*, 1- by 6-inch center support, notched to hold flue in place.

2. *Moving, turning, or mixing wheat.*—Wheat may be elevated or shoveled from bin to bin or from pile to pile, or spread out on the ground or in a driveway in a thin layer to avoid heating. Moving wheat by hand is laborious but it aerates the grain and tends to keep it from spoiling. The success of these practices depends largely upon the humidity of the air and therefore wheat can be expected to dry only when drying weather prevails. Small quantities of damp wheat are sometimes dried by mixing them with dry wheat. This is practicable only when the moisture content of the mixed grain will be sufficiently low for safe storage.

3. *Ventilation devices.*—Wheat that is properly dry and cool when stored has little need of ventilation, therefore devices to pass air through the wheat are not required in bins for loans under seal, and the presence of such devices in a bin will not alter the requirements as to permissible moisture content.

Experience and careful tests have shown that drying wheat by bin ventilation is usually very slow in humid regions. Chiefly because of the high relative humidity of the air, very little moisture can be

removed from the grain by passing air through it. Bin ventilation does allow the escape of heat from the grain, thus retarding spoilage, but in humid regions it cannot be depended upon to remove sufficient excess moisture to prevent eventual molding and souring of wheat stored for long periods. These statements do not of course apply to mechanical drying by using heat or refrigeration.

In the drier areas, good results have been obtained with the following types of ventilation in wheat which contained only a moderate amount of excess moisture:

1. Horizontal flues covered with fly screens (fig. 20). These flues when placed about 2 feet apart in the bin, with the ends opening into fresh air but protected from entrance of snow and rain, permit the gradual escape of moisture from the grain during dry weather. They should be closed tightly when the bin is fumigated.

2. Bins with floors of perforated metal fly screen laid over hardware cloth. Passage of air through bins of this type tends to equalize

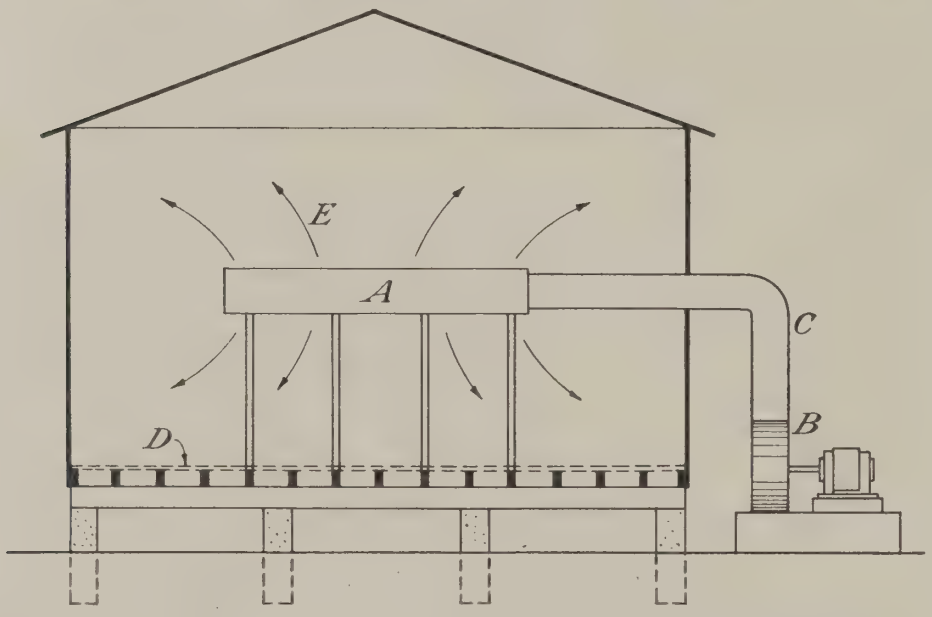

FIGURE 21.—An effective system of forced ventilation in dry climates for a 1,000-bushel bin. *A*, 8-sided air box 1 foot deep, 7 feet across, made by covering wood frame with fly screen; *B*, rotary blower driven by ½- to 1-horsepower motor; *C*, 10- to 12-inch air pipe; *D*, floor of fly screen supported by hardware cloth and wood strips; *E*, paths of air through wheat.

moisture between damp and dry layers of grain and to lower the temperature, thus retarding formation of hot pockets; but it cannot be depended upon to remove much excess moisture. One way to close such a bin for fumigation is by banking earth around the bottom.

3. Bins with perforated walls and a large central flue tightly connected to a suction cupola on top. These bins provide some air movement through the grain but when there are layers of damp wheat and dry wheat, the air tends to short circuit through the dry layers and may not completely dry out the bin. It is very difficult to make a bin with perforated walls sufficiently airtight for satisfactory fumigation and this is a serious objection to its use in areas where insect infestation is likely (fig. 22).

4. *Forced ventilation.*—The forced ventilation system shown in figure 21 has been found very efficient where the relative humidity of the air is low. In western Kansas the moisture content of a 500-bushel bin of wheat was lowered almost 5 percent in a week by using a blower operated continuously by a ½-horsepower motor. Almost any type of blower can be used to create ventilation through wheat in a bin, but fans which move a large volume of air at low pressure are best fitted for this work.

PROTECTING FARM-STORED WHEAT FROM DAMAGE BY INSECTS AND RODENTS

Losses to farm-stored grain through insect attacks are due chiefly to inadequate storage facilities, to lack of proper fumigation, and to certain methods of harvesting and storage that favor insect development. The degree of insect hazard to wheat in farm storage varies with the region in which the wheat is grown (fig. 22), and special treatment is required in some localities to prevent damage by insects

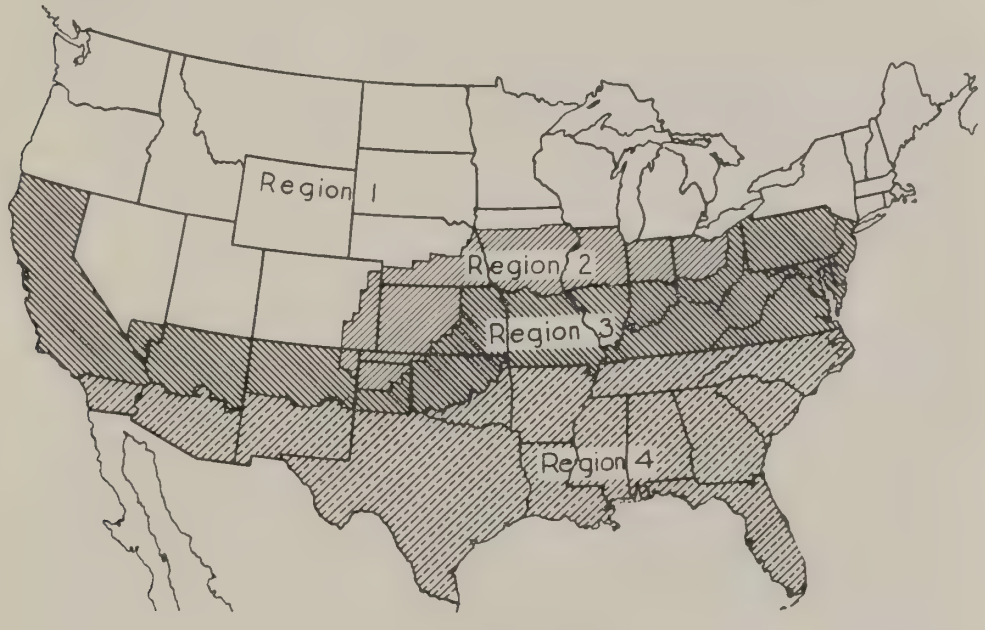

FIGURE 22.—Map indicating relative hazard to farm-stored wheat from insect attack. Region 1, best adapted for farm storage. Region 2, hazardous for farm storage in some years; frequent inspection and occasional fumigation necessary. Region 3, hazardous for farm storage every year; frequent inspection and fumigation necessary. Region 4, farm storage unsafe and not recommended; insect control difficult.

There are, however, certain preventive measures that must be taken in all regions if damage from insect attacks is to be prevented.

Grain storages of all kinds and in all regions must be thoroughly cleaned and accumulations of old grain removed. Spraying woodwork in wooden bins to kill insects in cracks and burrows is desirable, but the spray must be of a type that will not contaminate nor impart an odor to the grain that will be stored in the bins.

In all regions grain that is to be held in storage should be kept under observation and fumigated as soon as possible when insect

infestation is found. In regions 3 and 4 fumigation of all wheat immediately after storage is absolutely necessary in order to prevent serious damage by insects. The grain should be inspected within 2 weeks after this fumigation and the treatment repeated if living insects are discovered.

In the eastern part of regions 3 and 4 wheat should be threshed as soon after harvest as it is dry, in order to prevent serious infestation by the Angoumois grain moth.

Stored grain, whether under Government seal or not, should be inspected from time to time in all regions, to guard against reinfestation. In region 4 inspections should be made every month; in regions 2 and 3 every month until cold weather sets in and again in the spring; in region 1 in the fall and spring. Fumigation should be repeated as often as required.

FUMIGATION

For the treatment of infested wheat or corn in storage on the farm there is nothing cheaper, more effective, or more readily available than carbon disulphide.

Although the fumes of carbon disulphide are inflammable and explosive when mixed with air in certain proportions (see warning on page 22), this fumigant can be handled with reasonable safety if the proper precautions are taken. It should not be used to treat bins located in barns where the fire hazard cannot be properly controlled and where a fire or explosion will lead to serious losses. Fire insurance may be voided on buildings in which carbon disulphide is used. It is well adapted, however, for the treatment of grain storages that are segregated from other farm buildings. The fumes of this gas are quickly absorbed by the grain after it is applied and the danger from fire or explosion is not prolonged.

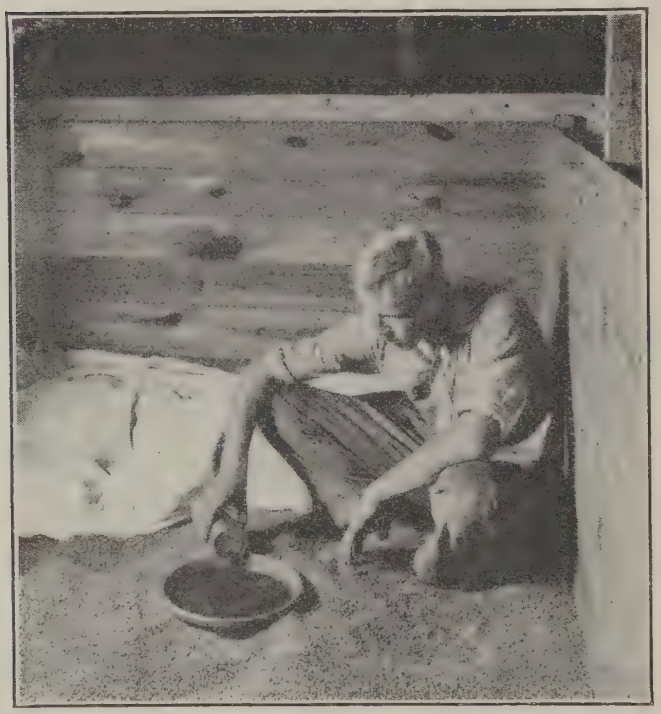

FIGURE 23.—In fumigating a farm bin either pour the heavier-than-air fumigant into shallow dishes as shown above or pour it directly upon the grain. Do not expect results if you bury the cans of liquid upright in the grain. Never expect results from placing the uncorked container in the bottom of the empty bin before filling the bin with grain. The walls of the bin shown are of a single thickness of tongue-and-groove material and are not well made for confining the gas. Leave the bin promptly after pouring out the liquid, to avoid breathing an excessive amount of gas.

On farms where the fire hazard cannot be controlled, a mixture of carbon disulphide

with carbon tetrachloride or a mixture of ethylene dichloride with carbon tetrachloride should be used. These mixtures do not have the fire hazards of carbon disulphide when used as grain fumigants. They are not as toxic as carbon disulphide alone, must be used in larger quantities, and hence are more expensive.

Carbon disulphide.—Carbon disulphide is a colorless, volatile liquid, which boils at 115° F. On exposure to air it evaporates, forming a

FIGURE 24.—Applying carbon disulphide or any liquid heavier-than-air fumigant. In this instance the carbon disulphide, carried on the pushcart in a metal tank, is pumped through a rubber hose into a perforated brass rod inserted into the grain. It is doubtful whether this method of application has advantages over simply pouring or sprinkling the liquid on the grain.

heavy vapor that can penetrate through deep bins of grain and is highly toxic to insects.

It is applied by being sprinkled evenly over the surface of the grain in the bin with a watering can or similar device at the rate of from 1 to 3 gallons per 1,000 bushels of grain, depending upon the tempera-

ture of the grain and the tightness of the bin (figs. 23 and 24). The cooler the wheat the larger the dosage required; fumigations at temperatures below 60° F. are not highly effective. The use of a tarpaulin to cover the grain after the fumigant is applied will aid in confining the vapor.

Carbon disulphide weighs 10½ pounds per gallon and ranges in cost from about 6 cents a pound in 500-pound lots to 30 cents a pound in 1-pound lots.

The vapors of carbon disulphide are poisonous to human beings if breathed for a long period. Exposure to light concentrations may induce a feeling of giddiness, which, however, will quickly pass off on one's coming out into the fresh air. Small quantities of carbon disulphide can be handled without danger to health by the ordinary person, although persons having any heart trouble should take little part in its application.

Remember, lighted lanterns, sparks from electric switches, sparks formed by hammering upon metals, lighted cigars, even hot steam pipes and static and frictional electricity may cause an explosion of carbon disulphide vapor; therefore fire in any form, or excessive heat, or frictional or static electricity should not be allowed near a bin or building that is being fumigated with this chemical.

Mixtures of carbon disulphide with other chemicals.—Mixtures of carbon disulphide with other chemicals such as carbon tetrachloride and sulphur dioxide, made for the purpose of reducing the fire hazard, are now available commercially at a price of about $2 per gallon f. o. b. factory. These mixtures consist of approximately 20 percent carbon disulphide and 80 percent carbon tetrachloride, to which may be added a small quantity of sulphur dioxide or other chemicals. When properly made such mixtures appear to be relatively free from fire hazard. It is not advisable for the layman to attempt the manufacture of such mixtures, since the safety of the fumigant from fire hazard is dependent upon its proper preparation. Only such mixtures as are sanctioned by fire insurance underwriters should be used. The toxicity of carbon tetrachloride to man is about equivalent to that of carbon disulphide.

Such fumigants should be used at the rate of from 3 to 5 gallons per 1,000 bushels, according to the temperature of the grain and the tightness of the bin, if results comparable to those obtainable from the carbon disulphide alone are to be obtained. The fumigant is applied in the same manner as carbon disulphide—by being sprinkled evenly over the surface of the grain.

Ethylene dichloride-carbon tetrachloride mixture.—Ethylene dichloride, a recently discovered fumigant, is effective in tight bins at temperatures above 70° F. Since the vapors of ethylene dichloride are slightly inflammable, it is customary to use this fumigant in combination with carbon tetrachloride. A mixture of 3 parts by volume of ethylene dichloride with 1 part of carbon tetrachloride is free from fire hazard under ordinary conditions. It can be used as a substitute for carbon disulphide where carbon disulphide cannot safely be used.

Ethylene dichloride is a colorless liquid with an odor similar to that of chloroform. It evaporates slowly when exposed to air, forming a vapor that is heavier than air and that will penetrate grain in a manner similar to that of carbon disulphide vapor. It has no adverse effect upon the germination of seeds and is not dangerous to

handle. It has an anesthetic action when breathed in concentrated form, but unless the fumes are breathed for a protracted period no harmful results need be feared.

In admixture with carbon tetrachloride it should be used at the rate of from 3 to 5 gallons per 1,000 bushels of grain and can be applied in the same manner as carbon disulphide. It can be purchased in 55-gallon drums at a cost of about 6½ cents per pound, delivered.

Fumigation of grain in small elevators.—In some wheat-growing regions grain is stored on the farm in small elevators that are equipped with machinery for handling grain and transferring it from one bin to another. The bins in such elevators are usually of the open-top crib type and have a capacity of from 1,000 to 5,000 bushels. Grain stored in such elevators can be treated in a different manner than grain that is in farm storage and cannot easily be moved. One of the most satisfactory fumigants under these conditions is a mixture of carbon disulphide and carbon tetrachloride and sulphur dioxide. It can be applied entirely to the surface of the grain in the filled bin in the same manner as that recommended for treatment of smaller farm bins. A dosage of 2 gallons of the mixture per 1,000 bushels of grain is recommended. If the grain is warm the surface method of application will give satisfactory results. If the grain is cool or cold, better distribution of the fumigant can be obtained by spraying, pouring, or dripping it into the grain stream as the grain is transferred from one bin to another.

SPRAYS

Sprays used in treating empty bins should not be of a type likely to contaminate or impart an odor to the grain that will be placed in storage. Any highly refined, odorless, and tasteless petroleum oil similar to that used in commercial fly sprays for use in dwellings, and to which has been added a small quantity of pyrethrum extract, is

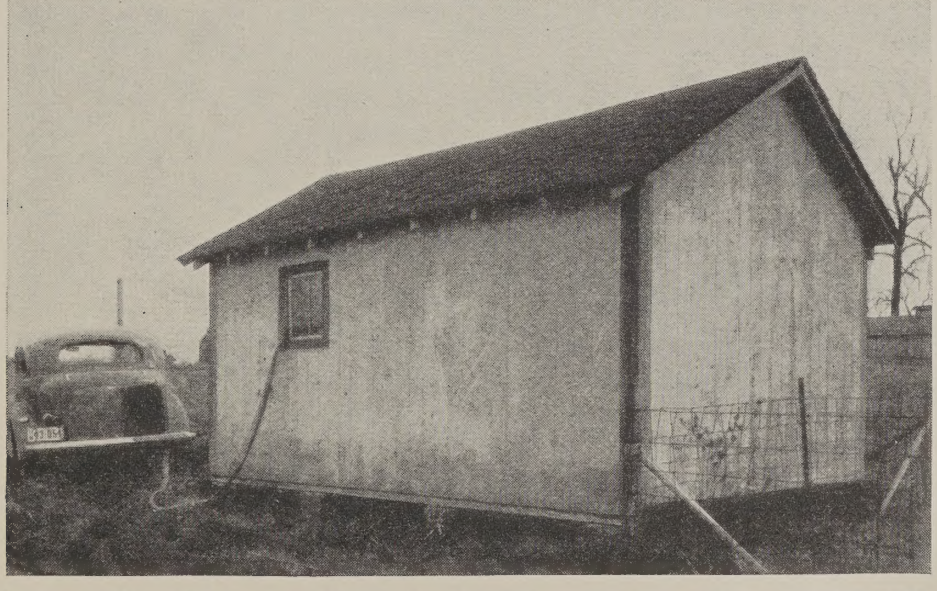

FIGURE 25.—Killing rats with exhaust gas from an automobile. Rats might be excluded by raising the building to 2 feet above the ground and capping the piers with large metal pans.

satisfactory. Since oil sprays are inflammable, care to prevent fires should be exercised in applying such a spray.

RIDDING PREMISES OF RATS

Several of the illustrations and text references in the preceding pages call attention to construction features that will exclude rats. Where it is not practicable to apply these methods to old buildings, other measures for dealing with rats and mice are needed.

Small buildings may be kept free from rats and mice by the periodical use of carbon monoxide gas from the exhaust of automobiles or tractors (fig. 25). All small openings should first be closed with burlap or other packing and the exhaust piped into the building with a short length of hose pipe. The engine should be allowed to run at moderate speed for 10 minutes or more for small buildings.

This method of fumigation has been found practical and reliable, and is inexpensive and free from fire hazard. Other ways of controlling rats are described in Farmers' Bulletin 1533, Rat Control.

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